RESEARCH SUMMARY

forest sciences
NELSON FOREST REGION

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- **Harvesting of single tree and group units were equally productive; it took about the same amount of time to harvest equal volume.**
- **Thoughtful block layout with regard to all passes, careful tree marking, and adequate supervision during harvesting are required to achieve management objectives.**

CASE STUDY: Harvesting Options in Highly Constrained IDF Stands in the Rocky Mountain Trench:

Whitetail Brook, Invermere Enhanced Forest Management Pilot Project Area

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INTRODUCTION

In 1994 the Invermere Forest District, Crestbrook Forest Industries, and the Forest Sciences Section of the Nelson Forest Region initiated an operational trial to examine the effects of season of harvest and root-removal treatments on sensitive calcareous soils found in the Rocky Mountain Trench area. Two adjacent sites were selected in the Whitetail Brook area southeast of Canal Flats, British Columbia (Figure 1).

Fine-textured calcareous soils would normally preclude spring harvesting or pushover logging, and significant levels of Armillaria would normally prevent the use of partial cutting systems. However, to maintain important winter range values for elk and still address Armillaria concerns, a partial cutting system with pushover logging was approved. Two silvicultural systems were tested: single tree selection and group removal.

OBJECTIVES

The objectives are to investigate the effects of:

1. Harvesting season (spring vs. summer) on soil disturbance.
2. Harvesting method (pushover vs. conventional handfalling) on soil disturbance.
3. Harvesting method and silvicultural system (single tree vs. group selection) on control of Armillaria root disease.
4. Harvesting method, silvicultural system, and season of harvest on regeneration establishment and stand development.

To assist foresters in developing prescriptions for sites with high levels of root disease, calcareous soils, and resource values that constrain clearcutting, this summary describes the harvesting operation and some preliminary results.

SITE DESCRIPTIONS

The two study sites are located near Kilometre 10.5 on the Whiteswan Forest Service Road (Figure 2). Both sites are within the Interior Douglas-fir dry mild (IDF dm2) biogeoclimatic subzone; however, the upper site is transitional to the Montane Spruce dry cool (MS dk1). Soil textures are fine sandy to silty clay loam, with carbonates at 25-30 cm and subsoil pH up to 8.5. Slopes are mostly gentle with few pitches up to 35%.

Armillaria exists throughout the two stands; infection levels greater than 20% were determined from pixel surveys. Site-limiting factors for harvesting and Armillaria treatments include: very high compaction hazard, high forest floor displacement, and unfavourable subsoils (carbonates) at 25-30 cm.

The pre-harvest stand consisted of a mature Fd/Lw component with minor amounts of Pl, Py, and Se and a site index of 15. Old stumps indicate a significant volume of large Lw (40+ cm) had been removed, likely 35 years ago for railway ties. In addition, both sites sustained mountain pine beetle outbreaks between 1979 and 1984 with 35-40% mortality.

STUDY DESIGN

Eight treatment units, each approximately 2-4 ha in size, were established within each of the two study sites. The treatment variables consisted of season of harvest, selection system, and harvesting method (Table 1).

Prior to harvesting, a permanent cruise plot 17.83 m in radius was established in each of the eight treatment units at both sites. Height, diameter, species, location, and condition (damage and health) were recorded for each tree. Pixel surveys were completed using 50-m in-

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tervals between transects to determine Armillaria levels and to locate infection centers.

Three soils pits were described in each treatment unit to determine soil disturbance hazard variation and soil properties, including forest floor depth, texture, coarse fragments, depth to unfavourable subsoils, and soil development. Samples were collected for soil and foliar nutrient analysis. Cores were extracted from two different depths (2-4 cm and 6-8 cm) to assess baseline aeration porosity and bulk density.

In 1997, stumps in one half of the conventionally harvested treatment units were treated with *Hypholoma fasiculare*, an experimental biological agent for controlling Armillaria.

SILVICULTURE PRESCRIPTION

Management Objectives

Management objectives for the site are to:

1. Maintain ungulate winter range values by retaining snow interception, thermal, and hiding cover.
2. Reduce infection levels of Armillaria by: i) stump removal (pushover falling), and/or ii) decreasing the proportion of the more disease susceptible Fd.
3. Manage the stand on a multi-aged basis for Py, Pl, Lw, Fd, and Sx sawlog production over a rotation of 80-100 years with anticipated stand entries every 20-25 years. Stand entries will be targeted toward removing approximately 20-30 m³/ha of Fd, Lw, and Pl sawlogs at each entry.

Single Tree Selection

One of the treatment objectives was, over several cutting cycles, to convert the even-aged stand to an uneven-aged structure to enhance and maintain wildlife values. Because stand structure conversion requires careful tree selection, cutting specifications were developed for single tree selection units prior to harvesting (based on stand structures, Table 2).

Species composition for the pre-harvest stand as compared to the target stand shows a slight increase, on a volume basis, of Fd. This may be interpreted as undesirable due the susceptibility of this species to root disease. However, cutting specifications were developed to reduce Fd density while protecting large Fd for their wildlife value, and because they represent the stand structure typical to fire-maintained ecosystems such as IDF.

Silviculture Prescriptions (SP) also detailed the following:

- Sufficient trees (Layer 1) were to be retained to approximate 17 m²/ha of basal area.
- Stems were targeted for removal in the following order: Fd>Sx>Pl>Lw>Py.
- Stems exhibiting poor form and vigour, and thinning of the crown (root rot symptoms), or showing any damage, were also targeted for removal. Lw showing signs of damage could be reserved for snag recruitment. Due to the high amount of mountain pine beetle mortality and Armillaria damage within the pre-harvest stand, poor quality trees were retained as necessary to achieve the desired diameter class distribution to meet wildlife objectives.

Figure 1. Location of the study site, in the Invermere Distnct in the Nelson Forest Region.

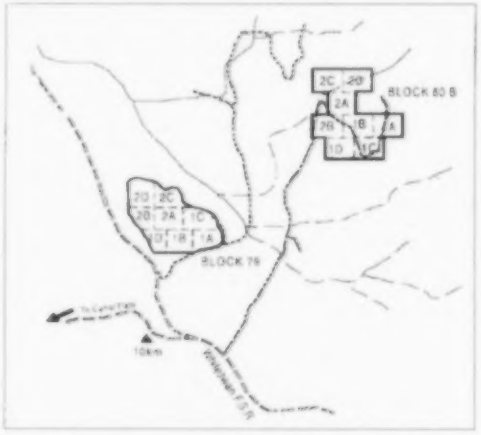

Figure 2. Location of the harvesting blocks.

- Understorey and damaged Pl stems >3 m in height were not slashed to avoid further spread of Armillaria.

Group Selection

Five to seven approximately 0.1-ha openings were harvested per treatment unit. All stems within Armillaria centers were marked for removal. All openings will be planted with a mixture of Py, Pl, Lw, and Ep, which are considered less susceptible to Armillaria than Fd.

HARVESTING OPERATIONS

Spring harvesting occurred between June 17 and July 23, 1996. Summer harvesting took place between July 24 and September 15, 1996. Respectively, May, June, and July were 20, 30, and 17% wetter than the 29-year average, and August was 89% drier.

Designated skid trails were laid out for all treatment units. In group selection units, trails were situated to efficiently access harvest areas and to minimize soil disturbance. In

single tree selection units, trails were spaced approximately 30 m.

Conventional Harvesting

One faller/bucker, and one crawler-tractor operator carried out the conventional harvesting. A small crawler-tractor (1.85-m outer track distance, 2.4-m blade) was used for skidding; this resulted in narrow trails. Single-pass random skidding to these trails was permitted (i.e. the skidder was permitted to drive through an area, or back off the main trail to pick up a load of logs). Trees were top skidded because more trees could be skidded at one time. In addition, many limbs were broken off during skidding, reducing delimbing time at the landing.

Table 1. Treatments.

Season	Silv. system	Harvest system	Treatment unit Block 79	Treatment unit Block 80
Spring	Single tree	Conventional *	1A	2A
		Pushover	1B	1B
	Group	Conventional *	1C	1C
		Pushover	1D	1A
Summer	Single tree	Conventional *	2A	1D
		Pushover	2B	2B
	Group	Conventional *	2C	2C
		Pushover	2D	2D

* An Armillaria control agent has been added to one half of each conventional treatment unit.

Pushover Harvesting

One small excavator (2.5-m outer track width), a bucker, and a skidder completed the pushover harvesting. An extra "thumb" was welded to the bucket to allow for easier manoeuvring of trees during falling. In single tree selection units the excavator would travel 5 m off the designated trail to push-fall additional trees. This process left a central swath of inaccessible trees, so harvesting coverage was not 100%. Stumps were bucked within the harvest area. Stems were butt skidded due to the falling direction. Productivity was reduced because fewer trees could be skidded at one time and more delimbing was required at the landing. Dead standing stems were not felled unless they were on the trail, or posed a safety hazard. Pushover harvesting was restricted to slopes <25%.

Tree Marking and Cutting Specifications

Table 2 summarizes stand structure by layer for the single tree selection treatment units. Detailed stand structure information was used to derive the following cutting specifications: cut all merchantable Pl; cut two of three Fd and Lw in the 35-45 dsh range; cut one of two FD and all Lw in the 50-60 cm dsh range; and reserve all stems over 65 cm.

But, rather than using these complex criteria, and to ease the selection process, the faller was instructed to leave approximately 17 m^2/ha of basal area by doing the following: cut any tree that causes a safety hazard, cut all merchantable lodgepole pine, reserve all trees greater than 65-cm dbh and all Py, and then remove three out of ten of both Fd and Lw in each diameter class. Initially, trees were premarked until the faller became comfortable with the criteria for selection.

The faller's cutting estimates, however, proved to be leaving extra trees. He then switched to using a prism and this resulted in a closer approximation to the cutting specifications. Even so, the faller found the species selection criteria too complex and too time consuming to implement while also keeping ahead of the skidder. Also, the

Table 2. Stand structure (based on one cruise plot per treatment unit).

Size class	Pre-harvest stand Ba/ha (m^2)	Pre-harvest stand Vol/ha (m^3)	Pre-harvest stand Stems/ha (no.)	Target stand Ba/ha (m^2)	Target stand Vol/ha (m^3)	Target stand Stems/ha (no.)	Post-harvest stand Ba/ha (m^2)	Post-harvest stand Vol/ha (m^3)	Post-harvest stand Stems/ha (no.)	Removed Ba/ha (m^2)	Removed Vol/ha (m^3)
Layer 1, >12.5 cm dbh	25.15	215.8	410	17.64	145.3	282	16.54	143.8	128	8.61	72
Layer 2, 7.5 - 12.5 cm dbh	1.62	8.64	206	1.47	7.86	154	0.96	0	52	0.96	0
Layer 3, 1.3 m height - 7.5 cm dbh	0	0	1080	0	0	922	0	0	158	0	0
Layer 4, <1.3 m height	0	0	739	0	0	208	0	0	531	0	0
Total	26.77	224.44	2435	19.11	153.16	1566	17.5	143.8	869	9.57	72

generally poor health and vigour of many of the stems made selection even more difficult. The excavator operator indicated that he would have preferred premarked trees because they are easier to see from within the machine.

Species and stand structure conversion require careful tree selection. Not only must species, size, and form be considered, but recognizing microsite, regeneration potential, forest health, and growth requirements are essential; this requires extensive forestry knowledge, and time.

Cutting specifications should not rely entirely on stand tables because they generally do not reflect the quality of each tree size class and species. Field evaluations are required. To further simplify the criteria, remove poor quality trees before average or good stems. Also, use broad diameter classes, at least 10-15 cm, for Layer 1 trees.

PRELIMINARY RESULTS

Production and Costs

A total of 4320 m^3 were harvested from 60 ha, an average of 72 m^3/ha. Harvesting in single tree and group units was equally productive; the same amount of time was required to harvest equal volume. This was largely due to allowing single-pass random skidding versus pulling line in single tree selection treatment units. Ultimately, there were no differences in wood quality despite the presence of Armillaria in the group selection areas.

Damage to Remaining Stand

Damage to the overstorey was minimal, generally less than 5%. However, most of the understorey was damaged, particularly in the pushover treatment. This is in part due to random single-pass skidding. This is comparable to the results of a similar study near Nakusp, BC (BCMOF 1996). Post-harvest surveys indicated that less advance regeneration (Layers 3 and 4) survived in the pushover blocks (16%) than in the conventional blocks (48%).

Soil Disturbance

Soil disturbance results will be discussed in another Research Summary for the Whitetail Brook area (in progress).

All measured disturbance levels were within SP limits. Season of harvest (i.e. spring vs. summer) was not statistically significant for soil disturbance levels. However, there was a difference between silvicultural systems; single tree pushover treatments caused the greatest levels of disturbance, while hand-felled group harvesting produced the lowest levels. This is because the skidder travels over more of the ground with single tree selection. Also, pushover falling causes more disturbance than hand falling. In all cases, the dominant soil disturbance category was "repeat machine traffic" from skid trails. Forest floor displacement levels were well under prescribed limits regardless of the treatment.

Skidding disturbance was assessed as part of the net area to be reforested during soil conservation surveys. Alternatively, the trails could have been classified within the SP as permanent access structures because they will be used in future harvesting entries. This strategy results in a greater percentage of permanent access structures in the area, yet the overall stand productivity may be protected because fewer trails are required during the rotation. Techniques such as pulling line, or using an excavator to hoe-forward logs, could reduce the extent of permanent skid trails needed. Also, low-impact harvesting strategies should be considered when practicing random skidding (for example, off the ends of permanent trails). In the IDF, these strategies include harvesting on dry or frozen soils.

SUMMARY

Single tree and group selection cuts were operationally and economically feasible, regardless of harvesting season or system. Damage to the overstorey was insignificant; however, most of the understorey, especially in pushover treatments, was damaged or killed.

Soil disturbance was not affected by season of harvest. However, harvesting method and silvicultural system did affect disturbance levels. Pushover single tree treatments resulted in greater disturbance levels than conventional group selection treatments, although all levels were within SP limits.

With the advent of the Forest Practices Code, operational planning requirements are extremely detailed for partial cutting systems. Nevertheless, the importance of correct harvesting techniques cannot be overemphasized. Thoughtful block layout with regard to all passes, careful tree selection and marking, and adequate supervision during harvesting are required to achieve management objectives. Without consistent effort there is potential for significant negative results. Productivity may decline due to an extensive skid trail network, and stand structure objectives may not be achieved. The effects would reach well into the next rotation and could influence future harvesting options, regeneration, and long-term productivity.

REFERENCES

BCMOF. 1996. *Shelterwood Harvesting in Root Disease Infected Stands - EP 1186 Preliminary Results - Ice Road.* Forest Sciences Section, Nelson Forest Region. Research Summary RS-030. 4pp.

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